Modelling the characteristics and dynamics of surfzone transverse sand bars observed on natural beaches

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Patches of transverse sand bars have been observed in the surf zone of several beaches, spaced with a remarkable alongshore periodicity (from 20 to 200 m). A transverse bar is an elongated accumulation of sand attached to the low-tide shoreline that extends inside the surf zone with an oblique orientation up to 1 m depth. Many events of formation and evolution of bar patches were recently observed at Noordwijk beach, the Netherlands [*Ribas and Kroon* (2007)]. The bar crests deviated from the shore-normal against the longshore current flow (up-current orientation).

A possible explanation for the formation of this type of bars is based on the concept of morphodynamic self-organization. Topographic perturbations superimposed on an alongshore uniform beach induce hydrodynamic perturbations, which can lead to convergence of sand transport over the bars, hence producing a positive feedback. Stability analysis is a convenient tool to investigate the possible feedbacks. It yields information about the shape, the growth rate and the migration speed of the initially emerging modes. A morphodynamic model has been developed and analysed to gain more fundamental physical knowledge about the characteristics and the dynamics of transverse bars. The model describes the feedback between waves, depth-averaged currents and bed evolution, so that self-organized processes can develop.

Realistic positive feedback leading to formation of up-current oriented bars like those observed only occurs if the stirring of sediment due to bore turbulence in the inner surf zone is included in the model. In that case, the depth-averaged sediment concentration decreases seaward across that zone. This, in combination with an offshore-directed flow over the bars, leads to accumulation of sediment in the crest areas. Including the dynamics of the wave rollers is essential because they create the turbulent bores that lead to significant sediment resuspension in the inner surf zone. The model is applied to the specific wave and bathymetric conditions measured at Noordwijk. The modeled wavelength, crest orientation and growth rate are in good agreement with observations but the model overestimates the migration rates. Both in the model and in the observations, the most favorable conditions for bar formation are obliquely incident waves of intermediate heights.

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